Appendix E: Critical Lane Volume Analysis

The Critical Lane Volume Analysis from Current Traffic and Approved Development on Rockville Pike Technical Memorandum was prepared by AECOM for the City of Rockville on November 9, 2010

1.0 PURPOSE AND INTRODUCTION

The purpose of this memorandum is to describe an analysis undertaken in conjunction with the *Rockville's Pike: Envision a Great Place* neighborhood redevelopment plan. The analysis used the locally-accepted Critical Lane Volume (CLV) method of calculating intersection capacity to estimate an order-of-magnitude level of development that could be permitted under the City of Rockville's existing Comprehensive Transportation Review system of concurrency management. In a somewhat unconventional use of the CLV method, the consulting team estimated available capacity.

The City opted to pursue this analysis in order to understand the practical limits of plan implementation under current systems of review and infrastructure concurrency requirements. One of the key reasons for this analysis was because AECOM's original analysis in the first iterations of the draft plan showed some intersections in the planning area at or close to failing levels of service under existing (2008) conditions. This did not take into account the additional traffic expected to be generated by approved developments. The outcomes of this memorandum are not intended to serve as Rockville's Pike plan recommendations, but rather to identify the potential (based on existing traffic conditions) that the City has for allowing development as envisioned under the Plan and to present general conclusions in guiding next steps.

2.0 PRIMARY ANALYSIS

The analysis used intersection turning movement counts from February 2008, originally collected for the Rockville's Pike plan traffic analysis work undertaken in advance of and during the May 2008 design workshop.

Per City staff recommendation, one traffic count (for the intersection of Congressional Lane and Rockville Pike) was substituted with a 2004 count from the Maryland State Highway Administration to correct for a northbound through movement volume that was significantly and unusually higher than comparable movements at nearby intersections.1 To these volumes, it added traffic estimated to be generated from currently approved but as-of-yet unconstructed development along the Pike. The analysis of capacity and development potential followed four principal steps. Each of these is detailed in the following sections.

2.1 Generation of Trips from New Development

The City provided the planning consulting team with formal Transportation Reports for 11 approved developments. Because of the scale of most of these developments, the majority was not expected to generate 30 or more peak-hour trips and as such was not required to submit full Transportation Reports for review, providing only a total number of generated trips. The planning team used the balance of inbound and outbound trips for appropriate land uses in the peak hour as defined in the Institute for Transportation Engineers (ITE) Trip Generation Handbook to determine this balance for traffic distribution onto the roadway network.

In addition, the City and planning consulting team considered the proposed Mid-Pike Plaza development which, although outside of the Rockville city limits, is relatively large in scale and could be expected to generate significant impact even within the City. The effects of this development on the overall network were determined separately from those developments entirely within the City; this is discussed in more detail in Sections 3 and 4.

2.2 Distribution of Traffic onto the Roadway Network

The planning team used the two Transportation Reports with distribution patterns as the basis for applying rates of distribution to traffic added through the trip generation step described in Section 2.1. One of these patterns was from the Wootton Crossing Bank development report and the other was from the Twinbrook Station development report. The first of these was termed Pattern A and any development occurring in the area of the Pike north of Congressional Lane was distributed on this basis (with this set of developments referred to generally as Group A). The second was termed Pattern B and was applied to any development occurring south of Congressional Lane.

This division was made in order to account for the potential differences in east-west traffic dispersion. In the case of each distribution model, east-west streets closer to the given development site are used more heavily to distribute traffic than east-west streets farther away in the corridor. For example, the Woottons Crossing Bank is assumed to distribute more traffic to streets such as Wootton Parkway and Edmonston Drive than it is to Twinbrook Parkway. By considering both and dividing the corridor accordingly, the traffic impacts of each particular development (and particularly turning movements from Rockville Pike that they generate) can be better understood and evaluated.

The City recommended that certain distribution factors from these Transportation Reports be adjusted to more closely match real-world conditions. The planning team made these adjustments per the City's recommendations as follows:

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[1] The 2008 turning movement was unusually high compared to other data, especially the counts representing the intersections immediately to the north and south of that intersection at the same time. Traffic counts on Rockville Pike can change from year to year (and even day to day). For example, another count taken at the same location in 2009 was lower than the 2004 count referenced and used in the analysis. The planning consulting team used the 2004 count as a median value because it was generally consistent with the through-moving volumes at adjacent points on the corridor.

Table 2.2.1 Intersection CLV Based on Current Traffic and Approved Development

Group A Movement Pattern	Previous Assumption (from Twinbrook Station TR)	Revised Assumption (per City staff advisory)
To/from the North along Rockville Pike-Hungerford Drive	25%	30%
To/from the North along First Street/Norbeck Road	10%	10%
To/from the West along Wootton Parkway	10%	10%
To/from the East along Veirs Mill Road	10%	20%
To/from the East along Ritchie Parkway	25%	10%
To/from the South along Rockville Pike	20%	20%

Table 2.2.2 Intersection CLV Based on Current Traffic and Approved Development

Group B Movement Pattern	Previous Assumption (from Twinbrook Station TR)	Revised Assumption (per City staff advisory)
To/from the North along Rockville Pike	25%	20%
To/from the North along First Street/Norbeck Road	6%	6%
To/from the West along Wootton Parkway	3%	3%
To/from the Northwest along Jefferson Street	2%	2%
To/from the East along Veirs Mill Road	1%	1%
To/from the South along Aspen Hill Road	8%	8%
To/from the East along Randolph Road	12%	12%
To/from the South along Rockville Pike	16%	21%
To/from the West along Montrose Road	27%	27%

Each of these distribution movement patterns was tied to the related turning movements at a given intersection. If a portion of a particular development project's anticipated traffic generation passed through one of these points, that number was assigned to the relevant traffic movements in each of the Pike study area intersections through which it would pass.

2.3 Aggregation of New Traffic Volumes

The traffic volumes resulting from the trip generation and distribution in Sections 2.1 and 2.2 were added back to the February 2008 to estimate the actual traffic likely to use the roadway system once this development is constructed. The volumes to be added were calculated by applying the regional distribution factors to specific turns at each intersection studied and adding the resulting turn movements to the current intersection volumes. Tables 2.3.1 and 2.3.2 (on the following pages) depict existing and new volumes for AM and PM peak hours, respectively.

2.4 Calculation of Critical Lane Volumes

The planning team used the Critical Lane Volume method described in the City of Rockville's *Comprehensive Transportation Review Guidelines* (CTR) to calculate critical lane volume for each intersection in the Pike study area in both AM and PM peak hours. The team compared this volume to the City's accepted thresholds, which may vary from intersection to intersection and even from one peak hour to the other based on the specific signal timing and phasing, to determine remaining capacity in terms of CLV.

The City's description of its methodology uses a two-phase signal timing scheme as its example. Many of the study area signals' use more complex phasing than this, often allowing lead-lag phasing to give left turn movements at least partial protection. In the cases where a left turn movement is given protected-permissive phasing, the number of left turns to be counted against the opposite direction's through movements was modified based on an assumption of free-flow turn lanes. This assumption was that 1,200 vehicles per hour can clear a free-flow turn lane, and the number of peak-hour left turning vehicles able to clear during a protected left turn phase would be that fraction of the hour given to all occurrences of this phase multiplied by 1,200.

CLV was calculated in this manner for both AM and PM peak hours. Several intersections show a deficiency of capacity suggesting that they cannot accommodate added traffic through development. The significant portions of traffic moving to and from locations outside of the immediate Rockville Pike study area further suggest that the corridor in general is limited in accommodating new traffic as well. This is discussed in greater detail in Section 4 of this memorandum.

Table 2.3.1 AM Traffic Counts with Additions for Approved Development

	Rockville Pike and Jefferson (MD 28) - Veirs Mill											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	0	422	471	0	953	796	252	645	0	497	2722	48
Added Counts from Development	0	5	14	9	79	15	199	105	5	14	173	0
Total Counts with Development	0	427	485	9	1032	811	451	750	5	511	2895	48
	Rockville Pike and Richard Montgomery - Dodge											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	30	63	84	32	83	9	65	859	15	0	3310	37
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	30	63	84	32	83	9	65	859	15	0	3310	37
	Rockville Pike and Wootton Parkway - 1st Street											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	163	278	32	382	559	47	45	935	151	32	1706	160
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	163	278	32	382	559	47	45	935	151	32	1706	160
	Rockville Pike and Edmonston Drive											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	0	213	345	115	361	110	96	1058	24	30	2093	10
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	0	213	345	115	361	110	96	1058	24	30	2093	10
	Rockville Pike and Country Club-Best Buy Entrance											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	3	0	6	9	2	9	15	601	6	31	3012	25
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	3	0	6	9	2	9	15	601	6	31	3012	25
	Rockville Pike and Templeton Place											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	31	5	24	38	5	5	75	1061	12	12	2486	17
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	31	5	24	38	5	5	75	1061	12	12	2486	17

	Rockville Pike and Congressional Lane											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	163	10	62	29	19	16	50	1137	10	38	2568	208
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	163	10	62	29	19	16	50	1137	10	38	2568	208
	Rockville Pike and Halpine											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	51	76	77	27	45	140	34	851	16	200	2489	28
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	51	76	77	27	45	140	34	851	16	200	2489	28
	Rockville Pike and Twinbrook-Rollins											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	3	232	95	1	343	52	71	890	119	180	1935	29
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	3	232	95	1	343	52	71	890	119	180	1935	29
	Rockville Pike and Federal Plaza Entrance											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	2	1	55	5	2	17	25	1012	18	18	2265	18
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	2	1	55	5	2	17	25	1012	18	18	2265	18
	Rockville Pike and Bou Avenue											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	2	1	55	5	2	17	25	1012	18	18	2265	18
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	2	1	55	5	2	17	25	1012	18	18	2265	18
	Rockville Pike and Hubbard Drive											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	15	2	13	84	7	28	33	1412	98	56	2476	25
Added Counts from Development	0	0	0	0	0	0	0	0	0	0	0	0
Total Counts with Development	15	2	13	84	7	28	33	1412	98	56	2476	25

Table 2.3.2 PM Traffic Counts with Additions for Approved Development

	Rockville Pike and Jefferson (MD 28) - Veirs Mill											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	0	640	370	0	484	460	425	1543	1	629	1480	77
Added Counts from Development	0	73	181	14	25	24	64	306	17	22	231	0
Total Counts with Development	0	713	551	14	509	484	489	1849	18	651	1711	77
	Rockville Pike and Richard Montgomery - Dodge											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	111	101	190	43	36	9	146	1841	25	0	1882	31
Added Counts from Development	0	0	0	0	0	0	0	387	0	0	426	0
Total Counts with Development	111	101	190	43	36	9	146	2228	25	0	2308	31
	Rockville Pike and Wootton Parkway - 1st Street											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	182	492	5	244	323	53	115	1681	405	88	1421	89
Added Counts from Development	60	2	30	51	1	26	40	301	71	46	278	102
Total Counts with Development	242	494	35	295	324	79	155	1982	476	134	1699	191
	Rockville Pike and Edmonston Drive											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	0	332	231	67	158	103	270	2099	104	214	1427	40
Added Counts from Development	0	0	0	1	0	0	0	412	1	0	359	0
Total Counts with Development	0	332	231	68	158	103	270	2511	105	214	1786	40
	Rockville Pike and Country Club-Best Buy Entrance											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	9	1	4	59	0	16	13	2315	30	43	2177	18
Added Counts from Development	0	0	0	0	0	0	0	411	0	0	358	0
Total Counts with Development	9	1	4	59	0	16	13	2726	30	43	2535	18
	Rockville Pike and Templeton Place											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	108	3	71	66	3	12	33	2757	22	20	1587	30
Added Counts from Development	0	0	0	0	0	0	0	411	0	0	358	0
Total Counts with Development	108	3	71	66	3	12	33	3168	22	20	1945	30
	Rockville Pike and Congressional Lane											
	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	417	31	124	106	31	78	348	3081	7	59	1707	206
Added Counts from Development	-1	0	-3	0	0	0	-6	412	0	0	361	-3
Total Counts with Development	416	31	121	106	31	78	342	3493	7	59	2068	203

Rockville Pike and Halpine

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	122	73	112	63	169	308	153	3088	25	148	1645	32
Added Counts from Development	0	0	0	3	0	0	0	406	0	1	357	0
Total Counts with Development	122	73	112	66	169	308	153	3494	25	149	2002	32

Rockville Pike and Twinbrook-Rollins

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	3	303	112	2	364	134	89	2508	182	200	1556	31
Added Counts from Development	-13	-3	-27	0	-3	72	-27	619	0	98	865	-13
Total Counts with Development	-10	300	85	2	361	206	62	3127	182	298	2421	18

Rockville Pike and Federal Plaza Entrance

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	97	14	158	18	23	47	188	2142	40	47	1707	23
Added Counts from Development	0	0	0	0	0	0	0	592	0	0	838	0
Total Counts with Development	97	14	158	18	23	47	188	2734	40	47	2545	23

Rockville Pike and Bou Avenue

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	31	43	46	307	34	15	43	1912	437	116	1444	8
Added Counts from Development	0	0	0	0	0	0	0	592	0	0	838	0
Total Counts with Development	31	43	46	307	34	15	43	2504	437	116	2282	8

Rockville Pike and Hubbard Drive

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Existing Counts	49	14	39	161	7	129	42	2500	252	132	2004	17
Added Counts from Development	0	0	0	0	0	0	0	592	0	0	838	0
Total Counts with Development	49	14	39	161	7	129	42	3092	252	132	2842	17

3.0 OUTCOMES OF CLV ANALYSIS

The results of the CLV analysis are given in the table below. Highlighted items represent those intersections exceeding the City-adopted CLV standard for that intersection. CLV standards vary by intersection based on the number of phases and cycle lengths. The maximum intersection capacity MD 355 does not exceed 1600 and 1700 vehicles per hour in the A.M. and P.M. peak hours, respectively.

Table 3.0.1 Intersection CLV Based on Current Traffic and Approved Development

TAZ	Intersection	AM CLV	Intersection CLV Standard	AM Remaining CLV	AM V/C	AM LOS	PM CLV	Intersection CLV Standard	PM Remaining CLV	PM V/C	PM LOS
714	Jefferson - Veirs Mill	**1908**	**1500**	**-408**	**1.27**	**F**	**1695**	**1650**	**-45**	**1.03**	**F**
	Richard Montgomery - Dodge	1507	1600	93	0.94	E	1184	1700	516	0.70	C
695	Wootton Parkway - 1st Street	**1425**	**1400**	**-25**	**1.02**	**F**	**1594**	**1550**	**-44**	**1.03**	**F**
	Edmonston	1447	1600	153	0.90	E	1637	1650	13	0.99	E
	Templeton	1134	1500	366	0.76	C	1355	1650	295	0.82	D
696	Country Club - Best Buy	1233	1500	267	0.82	D	1149	1650	501	0.70	C
691	Congressional Lane	1231	1400	169	0.88	D	**1731**	**1550**	**-181**	**1.12**	**F**
	Halpine	1141	1500	359	0.76	C	**1682**	**1650**	**-32**	**1.02**	**F**
	Rollins - Twinbrook	1093	1500	407	0.73	C	**1688**	**1650**	**-38**	**1.02**	**F**
Outside of City	Federal Plaza - Pike Center	1017	1500	483	0.68	B	1185	1650	465	0.72	C
	Bou	1100	1400	300	0.79	C	1266	1550	284	0.82	D
	Hubbard - Flagship Center	1152	1600	448	0.72	C	1594	1700	106	0.94	E

As the table shows, several intersections already exceed available capacity under the CLV calculation method. And although an intersection may have available CLV capacity in one peak period, the lesser capacity of the two peak hours is effectively what it can accommodate, as built development and physical street infrastructure cannot be changed from one peak hour to the other. This does not mean that these intersections absolutely cannot handle more development. It is worth bearing in mind that CLV is derived from the dominant direction of movement in each traffic signal phase, and in several cases there is significant 'space' left in the non-dominant direction to handle more traffic before balance of CLV between different component phases of an intersection is changed. Nonetheless, the CLV method is the City's adopted standard, and intersections already unable to add traffic capacity may be considered effective constraints on new development.

Although the minimum scale of development review requires consideration of only four adjacent intersections to a particular development's site, the distribution of intersections already exceeding CLV complicates the selection of any site that would be able to avoid consideration of at least one of them.

4.0 ADDITION OF MID-PIKE PLAZA

Montgomery County is in the process of approving a major development to the south of the Rockville city limits, Mid-Pike Plaza. Although not in the City of Rockville's municipal jurisdiction, the scale of this development suggests that it will have noticeable impact on the Pike and other transportation facilities nonetheless. The original

development potential estimated through the steps described in Sections 2.1 through 2.4 was recalculated with this development in mind. The intent of this was to demonstrate the difference in potential between the smaller-scale developments that the Rockville portion of the Pike currently supports (as a function of potential site yield, itself a balance of parking requirement and useable floor area) and the development potential that would remain if a major project outside of Rockville's city limits is approved and constructed.

The Mid-Pike Plaza trip generation was calculated based on the ITE *Trip Generation Handbook*. It assumed a development program equivalent to 90 percent of each of the specific land use categories as specified by Federal Realty in its initial program estimates; this slightly reduced program was assumed to account for constraints and inefficiencies in site layout that may keep a developer from realizing the fully entitled program. In addition, a 10 percent internal capture rate and 10 percent pass-by trip rate were assumed for the development to recognize its variety of complementary land uses and its large retail component. Trips were assigned to the roadway network using the Pattern B distribution, meaning that any southbound trips from the development were not counted in the Rockville Pike corridor.

The following table details the resulting CLV of Rockville Pike intersections after the addition of Mid-Pike Plaza traffic.

Table 4.0.1 Intersection CLV Based on Current and Approved Traffic, including Mid-Pike Plaza

TAZ	Intersection	AM CLV	Intersection CLV Standard	AM Remaining CLV	AM V/C	AM LOS	PM CLV	Intersection CLV Standard	PM Remaining CLV	PM V/C	PM LOS
714	Jefferson - Veirs Mill	**1931**	**1500**	**-431**	**1.29**	**F**	**1813**	**1650**	**-163**	**1.10**	**F**
	Richard Montgomery - Dodge	1531	1600	69	0.96	E	1251	1700	449	0.74	C
695	Wootton Parkway - 1st Street	**1474**	**1400**	**-74**	**1.05**	**F**	**1651**	**1550**	**-101**	**1.07**	**F**
	Edmonston	1482	1600	118	0.93	E	**1718**	**1650**	**-68**	**1.04**	**F**
	Templeton	1168	1500	332	0.78	C	1436	1650	214	0.87	D
696	Country Club - Best Buy	1268	1500	232	0.85	D	1231	1650	419	0.75	C
691	Congressional Lane	1265	1400	135	0.90	E	**1813**	**1550**	**-263**	**1.17**	**F**
	Halpine	1175	1500	325	0.78	C	**1763**	**1650**	**-113**	**1.07**	**F**
	Rollins - Twinbrook	1127	1500	373	0.75	C	**1846**	**1650**	**-196**	**1.12**	**F**
Outside of City	Federal Plaza - Pike Center	1051	1500	449	0.70	C	1297	1650	353	0.79	C
	Bou	1135	1400	265	0.81	D	1378	1550	172	0.89	D
	Hubbard - Flagship Center	1187	1600	413	0.74	C	**1706**	**1700**	**-6**	**1.00**	**F**

The addition of this development suggests that Rockville is likely to experience additional traffic and impacts as expressed in CLV, even if it no longer approves its own development. The regional nature of traffic and travel patterns in Montgomery County means that traffic typically passes through multiple jurisdictions, and that traffic impacts may be experienced by communities not immediately responsible for approving the development that generated these impacts.

5.0 POTENTIAL ADDITIONS OF FUTURE DEVELOPMENT

The City's Comprehensive Transportation Review (CTR) only requires measurement of intersection capacity and determination of development traffic impact when a development is expected to generate at least 30 trips in the peak travel hour. Although it is theoretically possible for development to be permitted when it generates traffic below this threshold, such a pattern of development is not consistent with the vision of the *Rockville's Pike* plan, nor is it likely to occur given the current land values of the corridor and the costs of development. In particular, this kind of an approach to allowing development is potentially threatening to larger developments proposed at future dates along the Rockville Pike corridor—when those developments undertake the CTR process in conjunction with their applications, the traffic counts they collect as the basis for their analysis will reflect the impacts and reduction in available intersection capacity coming from this added small-scale development. The City's CTR also emphasizes an acknowledgement of the potential impacts of small-scale development:

> *"The intent of the off-site threshold may not be circumvented through the submission of piecemeal development and permit applications or other approval requests. Upon submitting a preliminary plan of subdivision that generates less than 30 total peak hour site trips, the applicant must agree in writing that if future applications or approval requests result in 30 or more total peak hour site trips generated at one location, then the applicant will be required to complete and submit all TR components for the cumulative development package."*

5.1 Testing a Sample Development Project

To consider the conditions that a development more representative of the plan's vision would face, a hypothetical concept development project in the middle section of the Pike study area was tested for impact. Based on the critical lane volumes of intersections as reported in Table 3.0.1, at first glance it may appear that the area near the Best Buy entrance and Templeton Place intersection is the best suited to accommodate additional traffic impact. This location includes the portion of TAZ 696 within the Pike study area, the only TAZ not to have a currently failing intersection. Using a conceptual development program featuring vertical mixed uses such as those envisioned in the *Rockville's Pike* plan, a development in this area could feasibly include between 50,000 and 100,000 square feet of retail space and between 400 and 600 residential dwelling units. Considering either end of these ranges for both land uses, this would result in such potential traffic additions as shown in the table below:

Table 5.1.1 Potential Development Scenarios from Conceptual Development Program for Middle Pike development

Development Increment	AM Peak Hour Trips	PM Peak Hour Trips	Total Daily Trips
Concept A: 50K SF retail, 400 dwelling units	303	627	6,881
Concept B: 50K SF retail, 600 dwelling units	401	733	8,196
Concept C: 100K SF retail, 400 dwelling units	356	857	9,345
Concept D: 100K SF retail, 600 dwelling units	454	962	10,659

One important factor to consider in the CLV method of capacity calculation is that not all trips 'added' to an intersection will impact that intersection's composite CLV measure. This is because the composite CLV is a sum of the 'heaviest' directional volumes in each major set of movements through the intersection. For example, if a northbound movement is heavier than its opposing southbound movement but these two movements occur during

the same signal phase (which is a common occurrence and the typical model of signal timing on Rockville Pike), traffic volume added to the southbound movement through new development does not factor into the CLV measure unless it causes the southbound volume to exceed the northbound volume, thus becoming the new critical volume for that phase.

The City of Rockville's CTR requirements list the following as the minimum number of intersections to be studied in a Transportation Review. These numbers of intersections are determined by the peak hour trip generation from a proposed development.

Table 5.1.2 City CTR Requirements for Traffic Impact Study Area

New Peak Hour Site Trips	Minimum Number of Intersections to be analyzed (or all intersections within specified distance radius, whichever is greater)
0-29	No intersection study needed (Transportation Review not required)
30-150	4
151-350	8
351-700	12 or all intersections within a 0.45-mile radius
More than 700	16 or all intersections within a 0.5-mile radius

As the table of expected trip generation illustrates, even the minimum-intensity scenario as described in the concept development would generate 627 peak hour trips, enough to warrant study of 12 signalized intersections along Rockville Pike (the greater number of the two choices, as a 0.45-mile radius from the site only includes intersections along Rockville Pike). In the PM peak hour, assuming that this development follows the traffic distribution Pattern A, this sends 80 percent of exiting trips northbound (which is the peak direction of travel and usually defines the critical lane volume for the northbound/southbound signal phase) from this section of the Pike. The intersections of Templeton and Edmonston currently have capacity to absorb additional northbound development, although Edmonston has only 13 CLV vehicles remaining in its capacity. As the northbound movements determine capacity in the overall CLV measure, the expected addition of northbound vehicles would exceed this number, causing the intersection's overall CLV to exceed its threshold amount and fall to a failing level of service. Beyond this, the requirement of examining 12 intersections also needs to include Wootton Parkway and Maryland SR 28, which do not have capacity under existing conditions. Addition of northbound traffic to this intersection will only increase its overall CLV, as the northbound movement is already one of the critical volumes used to generate the component CLV.

The analysis of this minimum-intensity scenario is detailed in Table 5.1.3 on the following page, using the PM peak hour as the basis for analysis due to its higher impact from the proposed development program and because the PM peak hour already has a higher number of capacity limitations. The sample development discussed used Concept A from Table 5.1.1 and compared it to the available capacity in Table 3.0.1, or Rockville Pike traffic with approved development but *not* including the Mid-Pike Plaza in Montgomery County.

Table 5.1.3 PM Peak Hour Trips Generated from Middle Pike Concept Development

	Volume	Intersections where this volume can be absorbed in critical northbound/ southbound volume (with remaining CLV capacity)	Intersections where this volume cannot be absorbed in critical northbound/southbound volume
Inbound Trips	347		
Coming from South per Pattern A	69	Hubbard (up to 106) Bou (up to 284) Federal Plaza (up to 465) Country Club-Best Buy (NBL + EBL + EBR can equal up to 501)	Templeton (up to 295) Congressional (CLV determined by northbound, already exceeded by 181) Halpine (CLV already exceeded by 32) Twinbrook-Rollins (CLV already exceeded by 38)
Coming from North per Pattern A	278	Richard Montgomery-Dodge (up to 516) Edmonston (up to 292 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV)	Jefferson-Veirs Mill (CLV determined by both northbound and southbound movements; already exceeded by 45) Wootton Parkway (northbound is greater by 104 trips and currently determines intersection CLV; Pattern A would assign 60 percent of all inbound trips, or 208 trips, to SBT and thus increase existing CLV over threshold)
Outbound Trips	280		
Traveling South per Pattern A	56	Templeton (up to 295) Congressional (up to 527 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV) Halpine (up to 552 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV) Twinbrook-Rollins (up to 261 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV) Federal Plaza (up to 70 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV; 465 CLV vehicles remain in capacity beyond that) Bou (up to 82 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV; 284 CLV vehicles remain in capacity beyond that) Hubbard (up to 179 SB vehicles before SB becomes dominant movement in phase and determines intersection CLV; 106 CLV vehicles remain in capacity beyond that)	None
Traveling North per Pattern A	224	Country Club-Best Buy (NBL + EBL + EBR can equal up to 501)	Edmonston (CLV determined by northbound, only has capacity for 13 vehicles) Wootton Parkway (CLV already exceeded by 44) Jefferson-Veirs Mill (CLV already exceeded by 45)

It is worth noting that even the lowest-intensity scenario has several limitations relative to intersection CLV capacity. Although the CLV capacity measurement method can allow intersections to add traffic without affecting overall CLV (only if that traffic movement does not occur in the direction of critical volume), the traffic distribution models used in this analysis have both assigned traffic in both directions. In some cases, this sample development would add trips that would directly affect overall CLV of some intersections, many of which are already in excess of their CTR-determined thresholds. Traffic added to the peak direction in intersections that are already failing under the CLV method will only increase their volume-to-capacity ratio past 1.00 which, according to the City CTR process, either requires that the development applicant will need to mitigate this impact through costly physical improvements to the Pike intersections or suggests that the development cannot be permitted. For this reason, even the traffic analysis zone summaries of capacity do not necessarily reflect if and where development can be accommodated: based on the City's CTR requirements, the area of analysis is all but guaranteed to include intersections already unable to accept more vehicle trips in the peak hour.

6.0 RESULTS AND CONCLUSIONS

The City's current CLV standard results in several intersections not having adequate capacity for traffic movement. This effectively limits development along the Rockville Pike corridor and presents challenges in implementation of the Rockville's Pike plan.

6.1 Conclusions

The City's CTR system of development review does not readily allow development consistent with the *Rockville's Pike* plan vision to occur in the planning area. Development on a small scale (i.e. generating fewer than 30 vehicle trips in the peak travel hour) may occur, but this development does not serve to implement the vision plan and further reduces the corridor's capacity to accommodate new development. The City may consider the following alternative approaches if it wishes to accommodate new growth and development.

a. Implement engineering-based changes that increase intersection capacity. In many cases on Rockville Pike, intersection congestion occurs not only because of the volume of traffic using the intersection but also the ways in which that traffic is operating.

These changes can include physical changes to the roadway and intersection design, such as the addition of turn lanes. They can also include changes to traffic control, such as the replacement of signal infrastructure to allow different turning movement patterns and the re-phasing and retiming of signals to improve efficiency. Throughout the *Rockville's Pike* planning process, the planning team noted constraints to right-of-way, although these are not universally located along the corridor and some intersections may have opportunities to use this approach.

Increases in capacity from engineering-based solutions will allow additional traffic to pass through the intersection while maintaining acceptable levels of service. For this reason, any such approaches should be considered in tandem with an increase in CLV, primarily so that any commitment of resources to implement engineering changes is not foregone by a standard of measurement that does not recognize them.

b. Increase the CLV standard. As demonstrated in Table 3.0.1, certain intersections already exceeding the CTR-determined CLV threshold would not be in excess if the standard were to be raised. This would not require physical changes to street and roadway infrastructure but would rather adjust the City's adequate public facility policy to permit additional traffic in dominant movements.

As the City CTR specifies different CLV thresholds dependent on a specific intersection's signal cycle length and phasing, the amount by which standards could be increased would vary. However, if Mid-Pike Plaza is not considered, increasing CLV thresholds by 100 for each cycle length-phasing combination would restore each intersection except Congressional Lane to an acceptable level of service and open a greater range of the corridor to accommodating new development. If Mid-Pike Plaza is considered, this would need to be raised by a greater amount.

c. Develop a broader set of concurrency review measures, focused more on the corridor and the Plan area than on specific intersections. A focus on intersections as a basis for concurrency and adequate public facility management may pose problems when certain intersections reach their capacity limits. This is especially true in corridor-based districts, where the principal thoroughfare inevitably carries a large share of local traffic generated within the corridor. In these cases, traffic impact from new development is often reviewed over a greater length of the corridor than simply at the single intersection where development is located.

The draft Plan introduces a variety of techniques in use in other communities across the United States in order to introduce such an alternative system. Among other suggestions, it proposes the establishment of an infrastructure capacity tracking system where land uses—even after development is approved and the use is permitted occupancy—that demonstrate a reduction in vehicle impact restore capacity to the system. Most notably, the draft Plan recommends developing policies that strive for a greatly reduced share of trips related to the Pike being made by single-occupant vehicles, pointing to the Pike's two Metrorail stations, Montgomery County Ride On Transit, and an enhanced street network and the potential for pedestrian access that it suggests as ways to achieve this modal transfer. This in turn is intended to allow development projects to seek a greater program yield by creating an environment in which parking requirements can be relaxed or reduced in conjunction with a multimodal approach to travel demand management. Although the draft Plan's suggestions have been used in environments similar to the Rockville Pike corridor, they should be refined and vetted against complementary policies and current political will in order to develop a formal policy of multi-modal, place-based concurrency review.

6.2 Substitution of Development Program through Traffic Impact Equivalency

In the course of its development review process, the City may wish to use a traffic impact equivalency system to work with applicants to try to mitigate impact by pursuing different development program components. Table 6.2.1 on the following page is a sample matrix to facilitate the application of such a system. It is based on rates of PM peak hour traffic impact for a variety of land uses as reported in the ITE *Trip Generation Handbook* and provides multipliers to determine 'exchange rates' for different land uses based on an equal amount of traffic impact. Its intent is to allow a development applicant flexibility in changing components of the land use program once development has been approved without requiring the applicant to undergo further review of the modification. In short, once a certain level of traffic generation has been reviewed and approved, the applicant may use the equivalency system to substitute land uses provided that the resulting traffic generation stays within the approved amount.

Table 6.2.1 Equivalency Matrix for Substituting Development Program on Traffic Impact[2]

TO / FROM	Single Family (DU)	Multi-Family (DU)	Townhouse/ Condo (DU)	Senior Housing, Detached (DU)	Senior Housing, Attached (DU)	Hotel (Rooms)	Retail (0-49 KSF)	Retail (50-99 KSF)	Retail (100-199 KSF)	Retail (200-299 KSF)	Retail (300-399 KSF)	Retail (400-499 KSF)
Single Family (DU)	1.00 DU	1.08 DU	1.29 DU	2.58 DU	6.09 DU	0.94 Rms	0.07 KSF	0.10 KSF	0.12 KSF	0.15 KSF	0.16 KSF	0.18 KSF
Multi-Family (DU)	0.93 DU	1.00 DU	1.19 DU	2.38 DU	5.64 DU	0.87 Rms	0.06 KSF	0.09 KSF	0.11 KSF	0.13 KSF	0.15 KSF	0.16 KSF
Townhouse/Condo (DU)	0.78 DU	0.84 DU	1.00 DU	2.00 DU	4.73 DU	0.73 Rms	0.05 KSF	0.08 KSF	0.10 KSF	0.11 KSF	0.13 KSF	0.14 KSF
Sr. Housing, Detached (DU)	0.39 DU	0.42 DU	0.50 DU	1.00 DU	2.36 DU	0.37 Rms	0.03 KSF	0.04 KSF	0.05 KSF	0.06 KSF	0.06 KSF	0.07 KSF
Sr. Housing, Attached (DU)	0.16 DU	0.18 DU	0.21 DU	0.42 DU	1.00 DU	0.15 Rms	0.01 KSF	0.02 KSF	0.02 KSF	0.02 KSF	0.03 KSF	0.03 KSF
Hotel (Room)	1.06 DU	1.15 DU	1.37 DU	2.73 DU	6.45 DU	1.00 Rms	0.07 KSF	0.10 KSF	0.13 KSF	0.15 KSF	0.17 KSF	0.19 KSF
Retail (0-49 KSF)	15.04 DU	16.26 DU	19.38 DU	38.77 DU	91.64 DU	14.20 Rms	1.00 KSF	1.46 KSF	1.84 KSF	2.19 KSF	2.46 KSF	2.68 KSF
(50-99 KSF)	10.33 DU	11.16 DU	13.31 DU	26.62 DU	62.91 DU	9.75 Rms	0.69 KSF	1.00 KSF	1.27 KSF	1.50 KSF	1.69 KSF	1.84 KSF
(100-199 KSF)	8.16 DU	8.82 DU	10.52 DU	21.04 DU	49.73 DU	7.70 Rms	0.54 KSF	0.79 KSF	1.00 KSF	1.19 KSF	1.33 KSF	1.45 KSF
(200-299 KSF)	6.87 DU	7.42 DU	8.85 DU	17.69 DU	41.82 DU	6.48 Rms	0.46 KSF	0.66 KSF	0.84 KSF	1.00 KSF	1.12 KSF	1.22 KSF
(300-399 KSF)	6.12 DU	6.61 DU	7.88 DU	15.77 DU	37.27 DU	5.77 Rms	0.41 KSF	0.59 KSF	0.75 KSF	0.89 KSF	1.00 KSF	1.09 KSF
(400-499 KSF)	5.61 DU	6.06 DU	7.23 DU	14.46 DU	34.18 DU	5.30 Rms	0.37 KSF	0.54 KSF	0.69 KSF	0.82 KSF	0.92 KSF	1.00 KSF
Fast Food Rest.	49.97 DU	54.00 DU	64.38 DU	128.77 DU	304.36 DU	47.15 Rms	3.32 KSF	4.84 KSF	6.12 KSF	7.28 KSF	8.17 KSF	8.90 KSF
High Turnover Rest.	16.21 DU	17.52 DU	20.88 DU	41.77 DU	98.73 DU	15.30 Rms	1.08 KSF	1.57 KSF	1.99 KSF	2.36 KSF	2.65 KSF	2.89 KSF
Quality Rest.	11.18 DU	12.08 DU	14.40 DU	28.81 DU	68.09 DU	10.55 Rms	0.74 KSF	1.08 KSF	1.37 KSF	1.63 KSF	1.83 KSF	1.99 KSF
Bank (KSF)	81.75 DU	88.34 DU	105.33 DU	210.65 DU	497.91 DU	77.14 Rms	5.43 KSF	7.91 KSF	10.01 KSF	11.91 KSF	13.36 KSF	14.57 KSF
Convenience w/Gas (KSF)	90.46 DU	97.76 DU	116.56 DU	233.12 DU	551.00 DU	85.37 Rms	6.01 KSF	8.76 KSF	11.08 KSF	13.18 KSF	14.78 KSF	16.12 KSF
Movie Theater (Seats)	0.21 DU	0.23 DU	0.27 DU	0.54 DU	1.27 DU	0.20 Rms	0.01 KSF	0.02 KSF	0.03 KSF	0.03 KSF	0.03 KSF	0.04 KSF
Medical Office (KSF)	5.46 DU	5.90 DU	7.04 DU	14.08 DU	33.27 DU	5.15 Rms	0.36 KSF	0.53 KSF	0.67 KSF	0.80 KSF	0.89 KSF	0.97 KSF
Medical Clinic (KSF)	7.73 DU	8.35 DU	9.96 DU	19.92 DU	47.09 DU	7.30 Rms	0.51 KSF	0.75 KSF	0.95 KSF	1.13 KSF	1.26 KSF	1.38 KSF
Hospital (beds)	0.31 DU	0.33 DU	0.40 DU	0.80 DU	1.88 DU	0.29 Rms	0.02 KSF	0.03 KSF	0.04 KSF	0.04 KSF	0.05 KSF	0.05 KSF
Asst. Care Living Facility (units)	0.26 DU	0.28 DU	0.34 DU	0.67 DU	1.59 DU	0.25 Rms	0.02 KSF	0.03 KSF	0.03 KSF	0.04 KSF	0.04 KSF	0.05 KSF
Office (0-49 KSF)	3.19 DU	3.45 DU	4.12 DU	8.23 DU	19.45 DU	3.01 Rms	0.21 KSF	0.31 KSF	0.39 KSF	0.47 KSF	0.52 KSF	0.57 KSF
(50-99 KSF)	3.24 DU	3.50 DU	4.17 DU	8.35 DU	19.73 DU	3.06 Rms	0.22 KSF	0.31 KSF	0.40 KSF	0.47 KSF	0.53 KSF	0.58 KSF
(100-199 KSF)	2.46 DU	2.66 DU	3.17 DU	6.35 DU	15.00 DU	2.32 Rms	0.16 KSF	0.24 KSF	0.30 KSF	0.36 KSF	0.40 KSF	0.44 KSF
(200-299 KSF)	2.15 DU	2.32 DU	2.77 DU	5.54 DU	13.09 DU	2.03 Rms	0.14 KSF	0.21 KSF	0.26 KSF	0.31 KSF	0.35 KSF	0.38 KSF
(300-399 KSF)	2.01 DU	2.18 DU	2.60 DU	5.19 DU	12.27 DU	1.90 Rms	0.13 KSF	0.20 KSF	0.25 KSF	0.29 KSF	0.33 KSF	0.36 KSF
(400-499 KSF)	1.94 DU	2.10 DU	2.50 DU	5.00 DU	11.82 DU	1.83 Rms	0.13 KSF	0.19 KSF	0.24 KSF	0.28 KSF	0.32 KSF	0.35 KSF
Fitness Center	3.08 DU	3.33 DU	3.97 DU	7.94 DU	18.78 DU	2.91 Rms	0.20 KSF	0.30 KSF	0.38 KSF	0.45 KSF	0.50 KSF	0.55 KSF

[2] Units of development for each use are expressed in abbreviations as follows: 'DU' is dwelling unit; 'KSF' is thousands of square feet.

To take the conceptual Middle Pike development as an example, Concept A projected a trip generation of 627 PM peak hour trips, based on 400 multi-family dwelling units and 50,000 square feet of retail. If the City chose to permit this development—leaving aside, for purposes of this discussion, the aforementioned traffic impacts and CLV capacity—it could allow the developer to substitute, for example, 25,000 square feet of retail for 279 additional residential units. Likewise, if the developer desired to add retail beyond this scenario and had already been permitted, s/he could add 10,000 square feet of retail by reducing the residential portion of the program by 112 units. These calculations are detailed as follows:

Table 6.2.2 Example Equivalency-Based Substitutions from Conceptual Middle Pike Development

Substitution Desired	Amount of Adjustment	Equivalent of Component Land Use In Terms of Traffic
Less retail, additional residential	25,000 fewer SF of retail	279 units (1,000 SF of retail is equal to 11.16 multi-family units; 11.16 x 25 = 279)
More retail, less residential	10,000 additional SF	Reduction of 112 units of residential (1,000 SF of retail is equal to 11.16 multi-family units; 11.16 x 10 = 111.6, rounding up a unit as not to exceed agreed-upon traffic amount)
Added office, less residential	20,000 SF of office added to program	Reduction of 69 units of residential (1,000 SF of office is equal to 3.45 multi-family units; 3.45 x 20 = 64.8, rounding up a unit as not to exceed agreed-upon traffic amount)

6.3 Concluding Points on CLV

Revisions to the CLV standard or engineering-based changes, whether related to roadway design or signal timing, may help to realize additional efficiency under the current CLV-based traffic concurrency review system. However, any new development that these changes enable is likely eventually to exhaust the added margin of capacity and introduce a similar set of challenges to those documented in this memorandum. The following points are worthy of attention when considering changes of this nature.

1. CLV is derived based on the dominant travel movements at a given time. For this reason, an intersection near the limits of an adopted CLV standard may actually add more traffic than what appears feasible, provided it is not in the dominant direction and therefore does not alter the balance of individual signal phase CLVs. However, when this occurs, the actual operations of the signal are likely to appear more congested and burdened, mostly because they require a greater share of green time in the signal timing scheme. Many of the heavy northbound and southbound through movements on Rockville Pike are allowed equal signal time, regardless of which is dominant in a given peak hour. However, turning movements and cross-street movements are not necessarily timed in the same way; additions to these movements are likely to require added signal time in order to reduce delay, and this may come at the expense of major movements such as those on Rockville Pike.

2. Increases in CLV may also be exhausted by traffic generated from developments outside of Rockville. If an intersection-specific policy approach is to be retained in the City, it is important to coordinate development review with neighboring jurisdictions to understand the scale of impact and the threshold for concurrency that is acceptable and allows the City to realize added development.